Alqalam Journal of Medical and Applied Sciences. 2025;8(4):2877-2881
https://doi.org/10.54361/ajmas.2584114

Original article

Comparative Study of Hematological-biochemical Parameters in Indigenous Sheep Reared in Semi-Desert and Mountainous Areas of Libya

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Abstract

This study aimed to investigate specific hematological parameters in indigenous populations. Libyan sheep are raised under two contrasting ecological zones: semi-desert and highland regions. Blood profiles provide essential information regarding overall health conditions and adaptive mechanisms of animals in response to environmental challenges. A total of 50 apparently healthy adult female sheep (25 from each region) were examined. Blood samples were collected and analyzed for red blood cell count (RBC), white blood cell count (WBC), hemoglobin concentration (Hb), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), platelet count (PLT), Calcium (Ca), Phosphorus (P), and Total protein (TP). Significant differences (p-value < 0.05) were observed between groups. Highland sheep exhibited higher RBC, Hb, MCV, MCH, MCHC, and PLT values, while semi-desert sheep showed higher WBC count. These findings demonstrate the influence of environmental conditions such as altitude and temperature on the hematological profile of sheep, contributing to understanding their physiological adaptation.

Keywords. Sheep, Hematological-biochemical Parameters, Semi-desert, Highland, Adaptation.

Introduction

Sheep are among the most important livestock species in Libya, providing high-quality protein and essential nutrients that play a crucial part in food security [1]. Sheep play an important role in providing food and improving the livelihoods of livestock farmers [2]. Their economic value in meat production is closely linked to their health status, which can be effectively monitored through hematological parameters [3]. The Complete Blood Count (CBC) is an established diagnostic method for assessing overall animal health, metabolic status, and physiological adjustments to environmental conditions [4]. The profile of hematological parameters is an important tool for diagnosis and prediction of various diseases [5]. Numerous blood indices can serve as indicators to estimate the productive and reproductive performance of animals [6]. Factors such as climate, altitude, diet, age, season, and management practices significantly influence hematological values [1]. Oxygen availability at high altitudes stimulates erythropoietin production, enhancing red blood cell synthesis and hemoglobin concentration [7]. Understanding specific components of the complete blood count (CBC), including red blood cell levels and leukocyte distribution, enhances the accuracy of clinical evaluations and health assessments in sheep [8].

Sheep productivity is clearly influenced by the physical condition and overall welfare of the ewe [9]**.** Investigating how ecological factors influence blood parameters is essential for disease diagnosis, assessment of stress responses, and forecasting productive performance in sheep [10]. Hematological blood parameters serve as key indicators for assessing the health, nutrition, and physiological condition of ruminant animals [11]. Assessing hematological profiles has become a crucial method for diagnosing medical conditions [12]. Evaluating serum biochemical parameters is an invaluable assessment tool for characterizing nutritional status, metabolic performance, and overall health adjustments in indigenous sheep in a particular environment. Calcium (Ca) and Phosphorus (p) are two parameters of great importance since their homeostasis directly reflects the availability of essential minerals in the available forage for sheep, particularly in pastoral systems where nutritional quality can be highly variable [13]. In addition, Total Protein concentrations in the serum are a good indicator of dietary protein adequacy and nitrogen balance in the animal. Therefore, comparing these three parameters (Ca, P, and Total Protein) among the sheep populations inhabiting different ecological contexts, i.e., mountainous and semi-desert, provides considerable information pertaining to nutritional huddles and physiological mechanisms of adaptation that the indigenous breeds employ [14].

In this study, we attempted to use these biochemical differences to draw attention to differences in nutritional support provided by the mountain versus semi-desert grazing systems. Thus, the present study aimed to compare selected hematological and biochemical parameters of indigenous sheep reared in semi-desert and highland regions of Libya.

Received*: 13-10-2025 -* ***Accepted****: 11-12-2025 -* ***Published****: 20-12-2025*

https://doi.org/10.54361/ajmas.2584114

Materials and Methods

This investigation was conducted to analyze and compare specific hematological characteristics of ovine blood from indigenous sheep. A map of the study sites is used to illustrate the geographic distribution in Libya. (Figure 1). The mountain regions included: Al-Waseeta, Massa, and Farshita, while semi-desert regions included: Sallanta and Jardas, with particular emphasis on parameters including RBC, WBC, Hb, MCV, MCH, MCHC, and PLT.

Sample size

To calculate the sample size for comparing a blood parameter, CBC (continuous variable), between two independent groups (e.g., semi-desert vs. mountainous sheep), the appropriate formula is the sample size for comparing two means. As follows:

n: sample size per group

$Z_{1-\alpha/2}$*: Z-value for the desired confidence level (e.g., 1.96 for 95% CI)*

$Z_{1-\beta}$*: Z-value for the desired power (e.g., 0.84 for 80% power)*

Expected standard deviation (σ): 1.5 g/dL

Expected difference (d): 1.0 g/dL

$$n = \left(\frac{Z_{1-\alpha/2}+Z_{1-\beta}}{d/\sigma}\right)^2$$

$$n = \left(\frac{1.96+0.84}{1.0/1.5}\right)^2 = \left(\frac{2.8}{0.6667}\right)^2 = (4.2)^2 = 17.6$$

So, approximately 18 samples were required per group. However, a total of 50 samples were collected to avoid any potential sample loss or exclusion.

Animals

A total of 50 adult, clinically healthy, indigenous female sheep, aged between 1 and 3 years, were used for this study. Although male animals are often preferred due to lower hormonal fluctuations, female subjects were selected to represent the local breeding population. The animals were divided into two groups: Group A (Figure 2) consisted of 25 sheep from the semi-desert region. In contrast, Group B (Figure 2) included 25 sheep from the mountainous region characterized by cooler temperatures and higher altitudes. These figures illustrate the environmental conditions that may influence the physiological and hematological parameters of the animals.

Blood Samples

Blood Samples: Blood samples (5ml) were collected from two different flocks, A and B, through the external jugular vein of each animal into EDTA tubes in the early morning to minimize diurnal variation over several days. The parameters measured using an automated hematology analyzer included RBC, WBC, Hb, MCV, MCH, MCHC, and PLT, while Calcium, Phosphorus, and Total protein were analyzed using specific reagent kits.

Statistical analysis

Data were analyzed using SPSS (version 26). Results are shown as mean ±standard deviation (SD). An independent samples t-test was conducted to compare the groups, with $p < 0.05$ deemed statistically significant.

Ethical approval

This study was approved by the Al-Mukhtar Committee for Bio-safety and Bioethics, Omar Al-Mukhtar University; approval number is NBC: 007. A.

Results and Discussion

Data were collected from healthy animals. Figure 1 shows a map of the study areas located within the Green Mountain region, which is characterized by two distinct environmental zones situated close to each other, separated by only a few kilometers.

Received*: 13-10-2025 -* ***Accepted****: 11-12-2025 -* ***Published****: 20-12-2025*

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Figure 1. Study area

Figure 2. A and B show the clear differences in vegetation cover between the two study areas. Such differences in nutrition and environmental stress may contribute to the variation observed in hemoglobin concentration, RBC count, and other blood parameters.

Figure 2. A&B show the clear differences in vegetation cover between the two study areas.

Table 1 displays the variations in parameters between the two groups of sheep from semi-desert and mountainous areas. The results indicated how environmental factors
influenced the blood measurements of sheep raised in two different regions.

Table 1. Effect of ecological regions on hematological-biochemical parameters of adult indigenous sheep (1-3 years old) (M±SD).

Parameters	Semi-desert sheep (n=25)	Mountain sheep (n=25)
RBC (10^6/µl)	7.7 ± 0.4	9.8 ± 0.5
WBC (10^3/µl)	7.1 ± 0.9	6.5± 0.7
Hb (g/dl)	10.5 ± 0.6	11.6 ± 0.7
MCV (fl)	44.3 ± 2.8	47.8 ± 2.1
MCH (pg)	12.2 ± 0.8	14.7 ± 1.2
MCHC (g/dl)	27.3 ± 1.0	32.1 ± 1.4
PLT (10^3/ ul)	292 ± 38	317 ± 29
Calcium (mg/dl)	9.77±0.41	9.12±0.56
Total protein (g/dl)	7.20±0.52	6.80±0.45
phosphorus	4.50±0.35	3.95±0.65

M=Mean, SD=Standard deviation, a significant variation was recorded, P<0.05

Hematological indicators such as red blood cells, white blood cells, mean corpuscular volume(MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration(MCHC) act as crucial tools for identifying feed-associated toxicity [15]. These blood parameters are particularly useful when

Received*: 13-10-2025 -* ***Accepted****: 11-12-2025 -* ***Published****: 20-12-2025*

evaluating feed ingredients that may influence blood composition or compromise the overall health of livestock [16]. The mountain group showed a higher mean RBC count (9.8 ± 0.5 X 10^6/µl) compared to the semi-desert group (7,7 ± 0.4 X 10^6/µl) statistically significant difference ($p < 0.05$). This result shows a significant increase in RBC in mountain sheep, because a decrease in oxygen levels at high altitudes triggers the body to produce and release more erythropoietin, a hormone that promotes the formation of red blood cells. This response helps the organism adapt to the reduced oxygen availability in mountainous environments [17]. The result shows that the semi-desert animals have a high level of WBC counts demonstrate that they are capable of producing antibodies in the progression of phagocytosis and have a great degree of resistance to diseases [16].

Mountain sheep had significantly higher haemoglobin level (11,6 ± 0.7 g/dl) compared to those from semi-desert regions (10.5 ± 0.6 g/dl) ($p < 0.05$). The significant value of Hb concentration in ewe blood was recorded in the mountain region. This result agrees with [17]. They found the concentration of hemoglobin was increased in sheep living in the mountain region. Elevated levels of MCV, MCHC, and MCH play a critical role in diagnosing anemia and act as valuable indicators of bone marrow function in generating red blood cells [4]. The results verified a significant increase ($p \leq 0.05$) in the hematological parameters (RBC, Hb, MCV, MCH, MCHC, and PLT) in sheep that were reared in the mountain region compared with sheep that were reared in the semi-desert.

The results showed that the mean MCV for the sheep living in the mountain group was (47.8 ± 2.1 fl), while the mean MCV for the semi-desert group was (44.3 ± 2.8 fl); the difference between the two groups was statistically significant ($p < 0.05$). In a more recent study, [10] those researchers reported that MCV values differed significantly ($p < 0.05$) across breeds and environmental conditions. Uda sheep, which are adapted to semi-desert zones, showed MCV values around 45.86 fl, supporting the notion that environmental stressors like heat and dryness influence red blood cell indices. These findings align well with our study values and statistical significance [10]. The mean MCH for the sheep reared in the highland region was (14.7 ± 1.2 pg), while the mean MCH for the semi-desert sheep had a lower value (12.2 ± 0.8 pg), the difference between the two groups was statistically significant ($p < 0.05$). The MC'HC between the two groups of sheep revealed statistically significant differences. Specifically, the average MCHC for the highland sheep was (32.1 ± 1.4 g/dl), whereas the sheep from semi-desert regions had a lower average value of (27.3 ± 1.0 g/dl), MCHC in highland sheep had a higher value may reflect better physiological adaptation to altitude and superior dietary intake.

The PLT value for the highland group was (317 ± 29x103/ uL), whereas the semi-desert group had a lower mean value of (292 ± 38x103 /uL), and this result disagreed with [18] that reported a non-significant impact of breed on platelets. The levels of calcium ($P < 0.05$) and phosphorus ($P < 0.005$) were significantly greater in the mountainous area's ewes. This is perhaps because there is more and better grazing in the mountainous terrain than in the semi-desert. It is anticipated that pastures with sufficient moisture and soil fertility will include more of the critical macro-elements (such as calcium and phosphorus), which affect the animals' blood mineral levels and nutritional status. The highland ewes' total protein levels were likewise significantly higher ($P < 0.05), indicating that the mountainous habitat offers higher-quality protein meals. This indicates there is a more favorable nutritional and protein status for this livestock group. Calcium and phosphorus: To ensure adequate mineral metabolism and prevent diseases such as rickets and osteomalacia, the optimal calcium/phosphorus (Ca:P) ratio in ruminant diets should be between 1:1 and 2:1. In semi-desert environments, plants often have low nutritional value, limited protein and energy, and may be particularly deficient in phosphorus[13]. The marked decrease in the content of these minerals in the semi-desert group suggests a problem in maintaining mineral balance due to nutrient deficiencies in the environment. Total serum protein concentration indicates the nitrogen balance and overall nutritional status of the animal. The reductions observed in semi-desert regions generally reflect a deficiency in crude protein in the diet, leading to decreased synthesis of amino acids (such as albumin and globulins) essential for whey protein production, with negative effects on immune function and nutrient transport [14].

Conclusion

The hematological parameters of native Libyan sheep raised in semi-desert and highland environments varied significantly, according to this study. Higher RBC, Hb, MCV, MCH, MCHC, and PLT levels in Highland sheep indicated physiological adaptations to low oxygen levels, while higher WBC counts in semi-desert sheep indicated immunological stress in hot, dry conditions. These findings provide useful baseline data for tracking and managing sheep health and emphasize the importance of ecological factors in influencing hematological parameters.

Conflict of interest. Nil

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Received*: 13-10-2025 -* ***Accepted****: 11-12-2025 -* ***Published****: 20-12-2025*

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Received*: 13-10-2025 -* ***Accepted****: 11-12-2025 -* ***Published****: 20-12-2025*